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THE CONTROL OF "BUNT" IN WHEAT

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The purpose of the following paper is to discuss the efficacy of the methods of treatment employed in the control of bunt in wheat.

Results of control measures against "Bunt" in wheat carried out on experimental plots at the Cambridge University Farm.

1. *A comparison between bluestone, formaldehyde and copper carbonate.*

It is the custom to arrange each year a series of demonstration plots showing methods of controlling this disease. These trials have included a comparison of the formaldehyde and bluestone methods of treatment; and, in the past two seasons, a comparison between the above methods and the so-called dust or powder treatment which consists in treating the grain in a dry way with a powder such as copper carbonate. The percentage of bunt is estimated at harvest by taking a count of 1000 heads in a diagonal band. The size of the plots is not standardised, but in any one year the plots are uniform in size. In 1924 each plot consisted of approximately 300 ft. of drill, in 1925 of 200 ft. and in 1926 of 100 ft.

The land generally available for these experiments is a poor light soil, and normally not one which would be seeded for wheat.

The wheat used is "Little Joss," and in every case prior to sowing this is very heavily artificially contaminated with bunt spores. When this wheat is sown in these experimental plots it is literally black, and no farmer normally would sow such wheat.

It is sometimes considered that this variety is more susceptible to bunt than other varieties, and, in order to determine if this is correct, twelve wheats, as follows, were contaminated at the rate of one part of bunt spores to twenty-five parts of wheat and sown under conditions as uniform as possible in field experiments. At harvest, Wilhelmina showed 73 per cent. of bunted ears, Rector 55 per cent., Benefactor 84 per cent., Squareheads-Master 68 per cent., Victor 71 per cent., Marshal Foch 67 per cent., Iron 69 per cent., April Bearded 89 per cent., Yeoman 82 per cent., Little Joss 72 per cent., Rivett 78 per cent., Red Marvel 80 per cent.

These figures suggest that Little Joss is not more susceptible than other English varieties.

Table I.

Result of four years' trials of bunt control.

Treatment and method	Year	Germination	% of bunted ears
Untreated	1921–22	100	55
	1923–24	98	63
	1924–25	94	87
	1925–26	99	90
Formaldehyde (1 : 240) 1 pint to 30 gallons. Treated by steeping method	1921–22	100	0·6
	1923–24	98	0·2
	1924–25	81	0·3
	1925–26	97	0·0
Copper sulphate 2½%. Treated by steeping method	1921–22	93	7
	1923–24	91	3
	1924–25	78	6
	1925–26	90	2
Copper carbonate 3 oz. per bushel. Treated by the dusting method	1924–25	97	15
	1925–26	99	10

The following figures show that the best method with heavily contaminated seed is the formaldehyde treatment. In interpreting these figures, however, it must be remembered that the wheat used had previously been artificially contaminated at an extremely high rate, as witness the percentage of bunt in the untreated plots. Such grain would not be used by the farmer for his seed wheat.

It is of interest to note that germination has only once been materially affected by the formaldehyde treatment, whereas in every case the use of copper sulphate has caused an appreciable reduction. The low germination with the formaldehyde and copper sulphate in 1924–25 was due very largely to the sample being one which was badly threshed, many grains having been broken. It will be seen that the dusting method, using copper carbonate, has not affected the germination. It must be noticed, however, that an infection of 87 and 90 has only been reduced by this treatment to 14 and 10 respectively, whereas the formaldehyde and copper sulphate treatments have reduced it considerably more than this.

2. *Concentration at which to use formaldehyde.*

At what concentration is it most economical to use formaldehyde?

Salmon has shown previously[1] that formaldehyde diluted 1 : 320 (1 pint to 40 gallons of water) was as effective in controlling bunt as the 1 : 240 solution (1 pint to 30 gallons of water). At a later date[2] Salmon used

[1] *Journal of the Ministry of Agriculture*, xxvii, 1921, 1013.

[2] *Journal of the Ministry of Agriculture*, xxix, No. 8, Nov. 1922.

formaldehyde solutions at the following dilutions: 1 pint of formaldehyde to respectively 40, 60, 80 and 100 gallons of water. The results obtained showed that the formaldehyde became less efficacious the more it was diluted below the 1 : 480 (1 pint to 60 gallons) limit, but that at this concentration it gave a perfectly satisfactory control of bunt.

In the season 1923–24 formaldehyde was used at three concentrations: 1 : 240, 1 : 480 and 1 : 640. Both the steeping and sprinkling methods were employed. Table II shows the results of control measures carried out against bunt in wheat for the season 1923–24 when 40 per cent. formaldehyde was used at different concentrations. From these figures it is clear that there is a wide range over which formaldehyde is both safe and effective. The strength now recommended in the Ministry of Agriculture's leaflet No. 92 is 1 pint of 40 per cent. formaldehyde to 40 gallons of water (*i.e.* a concentration of 1 : 320). This gives a safe and economical method of controlling the disease.

Table II.

Results of bunt control trials with formaldehyde of different strengths.

	Treatment		Result	
Material	Strength	Method of application	Germination	% of bunted ears
40 Formaldehyde	1 : 240 (1 pint to 30 gallons)	Sprinkled*	98	0·6
40 „	1 : 240 (1 pint to 30 gallons)	Steeped	99	0·4
40 „	1 : 240 (1 pint to 30 gallons)	Sprinkled*	98	0·2
40 „	1 : 240 (1 pint to 30 gallons)	Steeped	97	0·0
40 „	1 : 480 (1 pint to 60 gallons)	Sprinkled*	99	0·2
40 „	1 : 480 (1 pint to 60 gallons)	Steeped	99	0·4
40 „	1 : 640 (1 pint to 80 gallons)	Sprinkled*	97	0·2
40 „	1 : 640 (1 pint to 80 gallons)	Steeped	99	0·5
Untreated	—	—	98	63

* Sprinkled at rate of 1 gallon to 2 bushels.

3. *Dusting method.*

This method was first applied by Darnell-Smith in Australia. In the United States of America it is stated that copper sulphate represses root growth, and formaldehyde the development of the young shoot. It was on this account that Darnell-Smith's method was adopted in that country.

In order to test the value of dusts such as copper carbonate in controlling the disease, trials have been carried out during the past two seasons[1]. Various so-called "copper dusts" have been used which included copper carbonate, copper acetate, copper sulphate, copper stearate and copper arsenite.

[1] *I.e.* 1924–5, 1925–6.

In the season 1925–26 the copper carbonate used was drawn from a 2-ton consignment to Australia, shipped mainly for the purpose of seed wheat dressing.

Little Joss wheat was treated with varying amounts of crushed "bunt balls," sown, and the percentage of bunted ears estimated at harvest by taking a count of 1000 ears from a diagonal band across each plot, these consisting of six rows, each 16 ft. long.

Table III shows the percentage of bunted ears from untreated and treated samples, previously contaminated at different rates with crushed "bunt balls." It is clear from these figures that infection varies directly with the spore load and that the efficacy of the dusting treatment is proportional to the rate of contamination.

In the same season three plots were laid down in which contaminated wheat was dusted with varying amounts of copper carbonate (*i.e.* 3, 6, 9 oz. to the bushel). These results, showing the effect of an increased dressing of copper carbonate, are analysed in Table IV.

Table III.

The percentage of bunt in treated and untreated wheat contaminated at different rates.

Rate of treatment with bunt	Treatment	% of bunted ears
1 to 25	Copper carbonate 3 oz. per bushel	11
1 to 25	Untreated	94
1 to 50	Copper carbonate 3 oz. per bushel	5
1 to 50	Untreated	78
1 to 100	Copper carbonate 3 oz. per bushel	3
1 to 100	Untreated	50
1 to 500	Copper carbonate 3 oz. per bushel	1
1 to 500	Untreated	25
1 to 25	Untreated	92

Table IV.

Showing the effect that an increased dressing of copper carbonate has in reducing the percentage of bunted ears.

Treatment	Rate	Germination	% of bunted ears
Copper carbonate	3 oz. per bushel	99	24
" "	6 oz. per bushel	99	14
" "	9 oz. per bushel	99	6
Untreated	—	99	86

Practical aspect of dusting wheat. For the application of this treatment a dusting machine is required. There are several of these on the American, Australian and German markets. Of these the "Calkins" wheat-treating machine was used by the writer during the season 1926–27, and was found to work efficiently. The makers state that 30 bushels per hour can be treated with this machine, but, working experimentally, we were not able to reach this standard.

If no such dusting machine is available a suitable contrivance can easily be arranged from an old barrel or churn, or more simply by rolling a barrel containing the grain and powder. There is, however, one serious objection to this treatment, and that is the danger of inhaling the fine copper powder. This danger may be overcome by the labourer wearing a mask, or it can be minimised by carrying out the dusting operation in the open air. Using small hand machines, or home-made contrivances, the danger to the workman by this method may be considerable. Given, however, a good machine—that is, one which is dust proof—the operation should involve no danger—or even necessitate the wearing of a mask. Although it is not suggested that at the present this method should supplant the use of formaldehyde or bluestone, it is considered that this treatment is efficacious when dealing with large bulks of slightly contaminated wheat.

RELATIVE COSTS FOR THE THREE TREATMENTS WITH FORMALIN, COPPER SULPHATE AND COPPER CARBONATE.

Costs based on treatment of seed for two days' sowing: viz. ten sacks —acreage sown, sixteen acres.

Copper sulphate treatment by the steeping method.

	s.	*d.*
2 man hours	1	4
2 boy hours	0	8
Material (2½ per cent. sol. copper sulphate) (10 lbs. copper sulphate at 4*d.* per lb. to 40 gallons of water)	3	4
	5	4

Approximate cost per acre, 4*d.*

Formalin treatment by the steeping method.

	s.	d.
2 man hours	1	4
2 boy hours	0	8
Material (1 pint 40 per cent. formalin at 1*s.* 9*d.* per pint to 40 gallons of water)	1	9
	3	9

Approximate cost per acre, 3*d.*

Copper carbonate treatment by the dusting method, using a machine[1].

	s.	d.
4 men hours at 8*d.*	2	8
2 engine hours	2	0
2 oz. copper carbonate per bush. (5 lb. at 1*s.* 4*d.* per lb.)	6	8
	11	4

Approximate cost per acre, 8*d.*

With reference to the price of copper carbonate a firm of Commercial Chemists, ——, states:

When we sell in more or less large quantities for export to Australia, we charge 8½*d.* per lb. for 5-ton lots in casks and 9*d.* per lb. if in kegs; for a ton or less we charge 9½*d.* per lb., and quite small quantities anything from 10*d.* to 1*s.* per lb. It also depends upon whether we sell to merchants or to actual users, as of course merchants have to make something out of the business themselves. If your enquiry refers to a price that farmers in this country should pay, we suggest about 1*s.* 3*d.* per lb. for anything below 1 cwt., and about 1*s.* per lb. for 1 cwt. and over.

Although the cost of treatment by the dusting method is at least twice that of the others, it must be borne in mind that the great advantage of the dusting treatment is in its convenience, enabling as it does seedsmen to send out stocks already treated. It is difficult to convert this very appreciable advantage into terms of money.

Feeding treated wheat to poultry. Although it is inadvisable to feed poultry with dressed wheat, it is desirable to ascertain whether injury to poultry will result from feeding seed wheat so dressed. Feeding trials on dressed wheat were accordingly carried out by the Poultry Nutrition Section of the Animal Nutrition Institute, Cambridge, 4 oz. of dressed wheat being fed daily per bird to four White Leghorn hens over a period

[1] Depreciation on machine not taken into account.

of 5 days. The trials showed that, for short periods at least, such dressed wheat can be safely fed to birds. The samples of wheat fed had been dressed as follows:

Sample 1. Wheat steeped for 2 minutes in 2½ per cent. copper sulphate solution.

Sample 2. Wheat steeped for 2 minutes in formaldehyde, strength 1 : 320.

Sample 3. Wheat treated with copper carbonate powder 3 oz. per bushel.

Analyses by Mr H. G. Pike showed that the dressed wheat contained 0·016 per cent. $CuSO_4.5H_2O$ and 0·101 per cent. copper carbonate respectively.

In concluding, the writer wishes to express his thanks to the following who have assisted him: Mr F. R. Petherbridge, with whom the writer co-operated in the 1923–24 experiments, Mr A. Amos for permission to reproduce the results of experiments in 1921–22, and for the figures relating to the costs of the three treatments, Mr E. T. Halnan for his report on feeding of "dressed" wheat to poultry, and Dr G. H. Pethybridge and Dr H. Hunter for constructive criticisms.

Summary.

1. Results of control experiments over a period of four years are given. The wet treatment, with formaldehyde and copper sulphate, are compared with the dry treatment, using copper carbonate.

2. The dusting method is discussed. It is shown that infection varies directly with the spore load and that the efficiency of the dusting treatment is proportional to the rate of contamination. For the usually slightly contaminated seed samples this treatment has been effective in controlling bunt.

3. The practical aspect of dusting wheat is discussed and its cost compared with the other treatments.

4. A report is given of the feeding of dressed wheat to poultry.

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